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Modern Surgical Anæsthesia

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I FEEL that I should open my remarks to you this evening by expressing sincere appreciation of the honour conferred upon me by the Robert Campbell Memorial Committee in inviting me to address you. It is particularly gratifying to be accorded this honour in the city where I obtained my qualification.

This oration has a two-fold purpose: its more important function is the commemoration of the man whose name it bears. To many of you Robert Campbell is not merely a name. The memory of his personality and work remains, to those who knew him, as vivid as it was at the time when his life was cut short in its prime. To the younger generation, and to some others, he is one of the famous men who have passed on, leaving behind him the heritage of a noble example which all would like to follow.

I count myself fortunate in that, twenty-five years ago, I was his pupil at the "Royal," and during my term in residence learned much from personal association with him. I remember well the impression he made upon me by the quiet strength of his personality. His surgical decisions were carefully weighed, and his cool, deliberate dexterity filled me with frank admiration; while his keen sense of humour and kindliness showed, at many an unexpected moment, that he was a very humane man at heart.

At the Children's Hospital his pioneer work on congenital hernia must have proved a blessing to many a grown patient alive to-day. It is probable that the statistics he collected in this branch of surgery alone remain unsurpassed at the

present time. No doubt the single fatality attributed to chloroform intoxication in this series of cases stimulated him to anticipate similar complications wherever chloroform was used, and here we have a link with the subject of this oration—namely, that the importance of anæsthetics did not escape his eager perception.

I cannot but feel that Robert Campbell would have been one of the first to appreciate the advances that have been made in anæsthetics in recent times and to encourage still further efforts towards improvement. Some account of what has been accomplished in this field should, therefore, be a fitting tribute to his memory.

It is obviously impossible to go deeply into all branches of anæsthesia in a short lecture. The main object in this paper is to deal with some important factors which have already proved their worth. In this respect it will be understood that I am more at home with an endotracheal tube than a fountain-pen, and if this paper falls short as an oration, it is a reasonable hope that when I have finished, you will have heard something of value on the practical side of anæsthesia. First of all I must say a few words about the past.

Early Developments.

No conception of the present day status of surgical anæsthesia can be arrived at without a brief reference to the history of its development.

It is well known that attempts to alleviate or even abolish the pain associated with operations date back to the very beginnings of surgery, and the potions and applications used for this purpose through the ages would probably fill a volume in themselves. In a recent paper, General MacArthur[1] refers to one of these methods as described by Guy de Chauliac in the fourteenth century. The patient inhaled the fumes from a mixture of opium, hemlock, hyoscyamus, and some other ingredients, and while under the influence, incisions could be made without pain. As MacArthur points out, this is probably one of the earliest references to general anæsthesia.

Mixed as it may have been with other ingredients, alcohol has, of course, been known since the earliest times as an anæsthetic. Even medical students may occasionally have experienced a return home with a black eye with no knowledge of how they got it and no recollection of any pain. Small wonder, therefore, that alcohol has enabled many a patient to withstand the ordeal of the knife.

It was not until the nineteenth century, however, that surgical anæsthesia in the modern sense was truly discovered. After some controversy, Morton's claim to priority appears to have been established by his use of ether for general anæsthesia in America in 1846. In the same year a dental extraction under ether was made in London; two days later it was used in surgical operations at University College Hospital, and from then onwards its fame spread like wild-fire. J. Y. Simpson of Edinburgh soon followed with chloroform.

Davy had suggested the possibility of nitrous oxide as an anæsthetic when he discovered it in 1800, but the profession was slow to appreciate its possibilities, and it seemed to achieve a merely frivolous reputation as a potential intoxicant. Poor Hickman, a young country practitioner who died in 1830 at the early age of 29, devoted the best part of his professional life to a fruitless endeavour to persuade

the medical fraternity that operations could be performed painlessly under the influence of gases including CO_2. He had performed several operations on animals, using this gas as an anæsthetic with considerable success, and his letters show that he had a clear conception of the possibility of painless operation on the unconscious human subject. It is a strange reflection that the work of these men failed to stimulate further investigation by contemporary scientists. But the fact remains that some fourteen years elapsed after Hickman's death before Morton proved that an operation could be performed without pain under the influence of ether, and that it was not until 1870 that nitrous oxide was established in general use in Great Britain.

To surgeons, the new-found boon of anæsthesia provided such a contrast to the pre-existing operative conditions that they remained complacent and contented. Herein lies the cause of the long period of stalemate in development which followed. Controversies arose from time to time over the relative merits and disadvantages of chloroform and ether. Nevertheless, these two drugs have held the field as the most widely used general anæsthetics. They continue to be employed because they are capable of producing good operative facilities when used by simple methods. This brings me to a consideration of the conditions existing to-day.

The Modern Status.

Here I must refer, unfortunately, to a lack of consideration evident in some surgical colleagues. Too long has the surgeon been oblivious to the side-effects produced by anæsthetics. "I do not care what you give, so long as you get the patient deep enough," is a phrase with which anæsthetists are familiar, and if the anæsthetist be in a junior position—as he frequently is—he will proceed to obtain that depth of anæsthesia regardless of any but its immediate effects. It is clear, therefore, that co-operation between the surgeon and anæsthetist is essential. When it is practised in the case of patients who are gravely ill, we are frequently surprised by the unexpected success of our efforts.

Deep ether anæsthesia, amounting practically to saturation, is the standard to which anæsthetists and surgeons have been bound in the past for the majority of operations. Where efforts have been made to break away from this tradition, post-operative results show definite improvement. This has been accomplished in one or two progressive hospitals in America and in at least one in England. In these institutions, the limitation of ether or the substitution for it, as far as possible, of less toxic agents such as N_2O and O, has resulted in shorter convalescence, fewer post-anæsthetic complications, and a reduction in mortality-rate. The economic aspect of this improvement is at once apparent. It means, in hospital, more available beds per annum and a reduction in cost per case.

Again, in the public mind many disagreeable factors are associated with anæsthesia. If we can modify this attitude by increasing our skill, patients will be encouraged to submit more readily to operations when a cure can reasonably be expected, instead of postponing the day until a hopeless stage of a disease, such as cancer, has been reached.

A surgical operation is not merely an exercise in applied anatomy; rather is it an exercise in applied biology in its widest sense. The need for improvement is unquestionable, for in spite of the high standard of surgical skill existing to-day, comparatively simple operations such as appendicectomy and tonsillectomy are still attended occasionally, not only by complications due to the anæsthetic, but by a definite mortality-rate.

The next question which arises is : how can the improvements of which we are in search be obtained? The advances which have been made are not due, as some are inclined to believe, solely to the discovery of the new drugs (which I shall deal with later) and to the swing over from what has been called "rag and bottle anæsthesia" to complicated apparatus.

Blomfield,[2] incidentally, has some trenchant remarks to make on this point. He suggests that, nowadays, the anæsthetist must have as good a working knowledge of pressure-gauges, flow-meters, valves, stopcocks, and manometers of all kinds as he must of the respiratory and circulatory system of the patient. He is pictured assessing the latter's condition by observing dials and scales and bags rather than by noting the colour, pulse, and breathing of the shrouded and often invisible figure who lies at the end of a piece of tubing. One sees the justice of this indictment. Apart from anything else, machines are not foolproof, nor are human beings infallible.

The keynote of successful anæsthesia, whatever the agent, drug, apparatus, or mode of application, is an accurate estimation of the patient's condition coupled with sound technique. Every individual has what for lack of a better term I must call a *physiological balance*. In youth and health this balance is elastic within a certain range. In the presence of disease, on the other hand, and in old age, interference with this balance may turn the scales against him. Moreover, unlike the standard laboratory animal, the human being is an unknown quantity in whom, even in health, the effect of environment and habits of life must be carefully considered before the make-up of the individual can be dissected into its different components and the influence of these gauged in relation to the anæsthetic.

The majority of the agents employed in anæsthesia are depressant in their effect. Some are actually destructive. It is essential therefore to judge beforehand, as far as possible, the capacity of the patient to withstand this action, superimposed as it is on necessary operative manipulation. At the present time this precaution is more imperative than ever, owing to the tendency to elaborate the anæsthetic prescription with drugs which are irrecoverable once they have been administered.

One further point may be mentioned here in connection with assessing the patient's condition—namely, blood-pressure estimations. The American custom of keeping an "anæsthetic chart" throughout the operation has now found its way to the British Isles. I have for several years made the practice of having regular blood-pressure estimations done at five-minute intervals during thoracic operations. In operations where severe surgical interference occurs, the information obtained by this means is invaluable, as it may enable the anæsthetist to say when certain surgical steps can be taken with safety. In any operation, observation of such

changes and of alteration in the pulse-rate give the greatest possible information on the state of the patient, and though the elaborate nature of the transatlantic method of recording these is in many cases impracticable, there is no doubt that much may be learnt from their study, in relation to the surgical procedure undertaken, that is both instructive and valuable.

Factors in Successful Anæsthesia.

At the risk of over-emphasising elementary principles, I must state that the first physiological consideration in anæsthesia is the maintenance of normal respiratory function, without which no agent can be considered satisfactory or safe. The airway must be kept free in all circumstances, and a good general maxim to bear in mind is that the administration of drugs should entail no greater diminution of respiratory rate and excursion than that which occurs in normal deep sleep. The importance of a free airway can hardly be exaggerated, but the chief point to remember is, not that it must be secured, but that it must be maintained.

Observation alone has taught me how frequently this is forgotten. Not only is it more difficult to maintain even or smooth anæsthesia in the presence of a partially obstructed airway, but the whole syndrome produced is a vicious circle which hampers the work of the surgeon and exhausts the patient. The resulting congestion is in itself a sufficient predisposing cause of post-operative pneumonia. Often in these circumstances an oxygen cylinder is brought into use. Oxygen is certainly valuable, but *only* when there is a free airway.

Endotracheal Anæsthesia.

This brings me to what is perhaps the most outstanding technical advance in modern anæsthesia—the endotracheal method in which Kuhn played such an important part. Intubation provides an airway which is patent in all circumstances. It does not imply complicated machinery either in getting the tube into position or in delivering the anæsthetic. Once the patient is intubated, anæsthesia can be maintained with an ordinary mask on inhalation principles, and connection to an apparatus is merely a refinement. Originally applied chiefly to certain operations on the head and neck, the success of endotracheal anæsthesia in this field has caused its extended use to other branches of surgery — particularly abdominal. There is, in fact, a growing tendency among anæsthetists to intubate at every opportunity. With this practice I emphatically disagree, since it is obvious that the airway can be kept free in many cases by simple means. At the same time, irrespective of the nature of the operation, there are certain types of patient, particularly the stout thick-necked variety, in whom control of the airway may become an increasing source of anxiety during the anæsthetic. In these there should be no hesitation in anticipating trouble by using the intubation method. Of the two methods of intubation—oral and, as I call it, "blind nasal"—the latter has particular advantages.

The curved rubber tube which I have devised for this technique and the method of passing it blindly through the nose,[3] constitute, I believe, a material advance in preventing trauma and ensuring ease of application. The basis of "blind" intuba-

tion lies in the fact that the human being normally breathes through the nose, and that there is one position of the head in relationship to the trunk in which the course of the airway from nose to larynx is at its maximum patency. The position is simply that of a soldier standing properly at attention, or of a plumber trying to locate an escape of gas.

With the head so held, the tube is passed along the floor of the nose. Administration of a little CO_2 at this time is useful, in order to abduct the vocal cords before insertion. The proof that the tube is properly *in position* is in the *breath-sounds,* which may be clearly heard at the end of the tube.

Intubation can, of course, be performed through the mouth with the aid of a laryngoscope, and contra-indications such as nasal sepsis, or deformity, or the site of operation, may indicate the oral route only. But when there is a free choice, the blind nasal method claims preference on account of the ridiculous ease with which it can be used in the majority of patients. Intubation puts an end to the grim old struggle we have sometimes seen between the surgeon trying to get his operation done under a handicap and the anæsthetist doing his best to keep the patient anæsthetised and alive at the same time.

It is in thoracic surgery that the most spectacular advances have been witnessed in recent times, and to these advances the endotracheal method has made a striking contribution. The removal of portions of the chest-wall under a local anæsthetic has long been an established procedure, but the extirpation of the whole or part of a lung has only been made practical, with reasonable safety, through improvements in anæsthetic technique.[4] Endotracheal anæsthesia *per se,* whether by inhalation or insufflation, gives no protection against the spread of secretions to the sound lung. Factors which contribute to this are the position of the patient on the table and the manipulation of the diseased lung by the surgeon. In such circumstances positive-pressure anæsthesia appears to be both useless as a protection and an actual danger in itself. Not only is it possible to open the chest with safety, but anæsthesia can be confined to one lung by means of an endobronchial tube, thereby protecting the sound lung from cross-infection during the operation. Endotracheal suction can be applied during operation when necessary. Further, by application of the principles of controlled respiration, the pulmonary excursion can be reduced to such an extent that in pneumonectomy the surgeon is enabled to sever the main bronchus when its movement has been brought to a standstill. When lobectomy for bronchiectasis is contemplated, the bronchus on the affected side can be blocked by a gauze tampon or by a balloon, thereby confining the secretions to the affected area.

A final application of endotracheal anæsthesia is cleft palate and hair-lip operation, even in infants it has proved itself to be an important contributory factor to surgical success. This is readily acknowledged by Kilner.[5] Again, Cade has come to regard endotracheal anæsthesia as a *sine qua non* for successful operations on the tongue.[6] It is easy to understand the advantage of being able to give N_2O and O through the endotracheal tube with a larynx under control and no respiratory obstruction, in contrast with the rather clumsy and Victorian method

of giving chloroform through a hooked tube, with the attendant difficulties of not being able to secure an even and light level of anæsthesia, and also adequate protection from the entry of blood, etc., into the trachea.

A certain amount of criticism has, however, been levelled against nasal intubation, on the grounds of trauma and the possibility of introducing septic material into the bronchial tree. Trauma which is, after all, avoidable is likely to arise with any form of instrumentation. In a twenty-year experience I have yet to record a single instance of pulmonary complications which can reasonably be attributed to this method.

I have just spoken of the importance of a free airway in maintaining satisfactory anæsthesia, and of the advantages offered by the endotracheal method. This seems to be a suitable moment for a few words on carbon-dioxide, already referred to in connection with intubation. It is only in the last few years that the value of this agent has been fully recognised. Owing to its specific action on the respiratory centre it can be used to accelerate induction, to stimulate sluggish breathing during the maintenance of anæsthesia, to hasten the return to consciousness after the operation, and to assist the aeration of the base of the lung during the post-operative period, thus minimising the possibility of post-operative pneumonia.

The proper control of CO_2 is, however, not always so simple as it sounds. In the closed system, so frequently used nowadays, unless some method of removing CO_2 is arranged for, accumulation occurs, giving rise to hypernœa, increase in systolic blood-pressure, and a greater tendency towards oozing of blood in the operative field. The incorporation of a soda-lime canister remedies these defects, and, if it can be cut out or in at will, enables proper control to be exercised and physiological conditions imitated. In addition it prevents loss of heat and water from the body.

A specially valuable application of this principle can be exercised in certain operations where the surgeon may require the breathing to be damped down or even stopped—so-called "controlled respiration." This can be achieved for short periods by squeezing the bag. The effect of this is to hyper-ventilate the lung with oxygen, and remove through the canister the greater part of the CO_2 from the lungs. There being no stimulus to natural respiration, voluntary breathing now ceases. Oxygenation must, of course, be maintained by occasional pressure on the bag. Natural breathing will recommence only when the CO_2 has been allowed to accumulate again to the threshold necessary to stimulate the respiratory centre.

Basal Anæsthesia.

The practice of trying to allay the patient's apprehension before operation by means of sedatives must be as old as surgical history. Some fifteen years ago a rather striking advance was made when drugs began to play an important part in the anæsthetist's stock-in-trade. Where formerly little else than a sedative effect was the rule, something more dramatic seemed called for, and nowadays patients commonly demand to be made completely unconscious before the anæsthetic proper is administered. The use of drugs to this end came to be termed basal narcosis, and we know how attractive it is from the patient's point of view. To the anæsthetist

also the smaller amount of the subsequent anæsthetic required by this system is an added advantage. Basal narcosis is still looked upon by some as not entirely devoid of danger. In fact I know of some surgeons who continue to refuse it to their patients. But I know also of many patients who have gone to other surgeons on account of such refusal!

No doubt the drugs which are powerful enough to produce coma must be considered dangerous—but the same may be said of chloroform, or even alcohol. When we consider the psychological aspect of anæsthesia, it cannot be denied that basal narcosis has proved to be a valuable asset, especially in operations upon children. The nightmare of a mask is a definite entity to a nervous child who has previously undergone the ordeal of a "straight" anæsthetic badly administered, and the same may be said of many an adult patient. But when a new drug or technique is discovered, in anæsthetics as in other branches of medicine, there is a tendency to apply it to every case regardless of indications or consequences. So also with basal narcosis. The patient's wish to be made unconscious in bed is an ever-increasing demand to which anæsthetists are tempted to submit, sometimes against their better judgment. A simple example will show how impracticable this may be: An extensive pelvic operation requires a low spinal anæsthetic, and the patient asks to be put to sleep before the injection. Here a firm line must be taken. A low block is best done with the intelligent co-operation of the sitting patient and on the operating-table. The spinal must be given first—it can be quite painless—and this can be followed by an intravenous barbiturate, such as evipan or pentothal, which induces unconsciousness pleasantly and quickly. Another difficulty arises when intravenous anæsthetics are used alone but are demanded before the patient, who is often aged and gravely ill, is in the theatre. In this instance delay during the journey to the theatre and from the ensuing preparations may cause loss of valuable anæsthesia and require a higher total dosage than is desirable.

I must now say a few words about the actual agents employed. Most of the drugs used for basal narcosis are, with the notable exception of avertin, barbiturates. Practically no limit exists as to the number of derivatives which can be produced, so that to the many which are already familiar continual future additions are to be expected. It is worth noting, that although evipan and pentothal are more effective than nembutal during induction, the former drugs are detoxicated so quickly that they contribute little to subsequent anæsthesia and practically nothing at all as sedatives in the immediate post-operative period. Both these drugs will be mentioned again in connection with intravenous anæsthetics. The oral use of barbiturates for basal narcosis is not to be recommended owing to their erratic absorption. This is particularly important in children, where difficulty in assessing the correct dosage also comes into the picture.

Apart from paraldehyde, the veteran basal hypnotic, avertin (given by rectal injection) requires special consideration. Avertin is perhaps the most popular basal hypnotic at present in use. Its value is undisputed. The peculiar virtue of avertin lies in its possession of considerable anæsthetic properties even when given in safe doses. As it readily induces muscular relaxation, it is the agent of choice

in certain abdominal operations when there is no contra-indication to rectal injection. It must be remembered that general muscular relaxation is often accompanied by a tendency towards obstruction of the airway. A constant watch for this must be maintained. Avertin is a most powerful drug, and the greatest care should be exercised in regulating the dose. It is not advisable in elderly or gravely ill patients.

When a basal narcotic has been administered, certain precautions are necessary in the immediate post-operative period. Much of the calumny which has been showered on these drugs is due to neglect of the airway at this time, and the nurse must be instructed to pay particular attention to this, also to withhold the administration of further sedatives as long as possible. If respiration is lagging, coramine or lobeline should be injected, and inhalations of carbon-dioxide and oxygen given at intervals.

The Anæsthetic Proper.

Having considered the basal hypnotics, I can now pass to the anæsthetic proper which supplements it, and will very naturally turn to nitrous oxide and oxygen as the most innocuous combination known. It causes no interference with metabolism or any destruction of tissue. It is also non-inflammable. Within the last decade, however, there has been a growing tendency among surgeons, physicians, and some anæsthetists to speak casually of "gas and oxygen" for any and every operation. It would be well, I think, if the position of this combination were put on an honest basis. Gas and oxygen means gas and oxygen, and nothing else. We should bear in mind that the potency of nitrous oxide and oxygen is limited, and honest anæsthetists will admit the use of an adjuvant such as ether in small quantities—but nevertheless ether. It is true that with the help of adequate basal narcosis, the scope of nitrous oxide and oxygen has been extended, but to press for muscular relaxation without these aids involves a degree of suboxygenation to my mind more dangerous than the use of a small amount of ether, and certainly less satisfactory from the standpoint of muscular relaxation.

By all means, then, let us employ nitrous oxide and oxygen as far as we can, but let us not delude ourselves into thinking that we are using nitrous oxide and oxygen for major surgery when in reality we mean nitrous oxide and oxygen plus something else.

Of course some may be ambitious to follow McKesson's secondary saturation technique. McKesson was reputed to be something of a magician with nitrous oxide, but I know definitely that he worked with a surgeon who was content to operate on a rigid abdomen. Secondary saturation practically amounts to periodic asphyxia. One experienced anæsthetist who saw McKesson in action described the physical signs of the patient as approximating those of impending death.

Having mentioned evipan and pentothal in connection with basal narcosis, it is now necessary to describe them under the heading of total anæsthetics given intravenously. This procedure must be considered as definitely established, as in addition to other advantages these drugs fill a gap which previously existed when an anæsthetic was required for short operations—particularly those in the region

of the head and neck, such as excision of eye, extraction of teeth, etc. Again, they have proved valuable in patients who are "difficult" under N_2O and in cases where muscular relaxation is required for a brief period for orthopædic manipulations.

Pentothal is in my experience the outstanding drug. Its forerunner, evipan, has some disadvantages which make it relatively unreliable—namely, failure to induce satisfactory muscular relaxation. With evipan there is frequently rigidity. With pentothal, muscular relaxation is the rule, and on this account a careful watch must be kept for respiratory obstruction through the tongue falling back or depression of the lower jaw. This is all the more important when it is remembered that respiratory depression with pentothal is more marked than with evipan. To combat respiratory depression with pentothal, Organe[7] has recently devised a technique in which N_2O and O is used to supplement the preliminary injection. The needle is kept in position in the vein, and as the demand for deeper anæsthesia arises from time to time a further injection of 1 or 2 c.c. of pentothal is given. The value of this method is that owing to re-breathing, an accumulation of CO_2 is obtained which acts as a respiratory stimulant, while the N_2O and O acts as a supplementary agent and enables economy in total pentothal dosage to be made.

It is worth while noting that, owing to its containing sulphur, pentothal should not be used when the patient is under treatment with prontosil or allied compounds.

Despite the advantage of these intravenous drugs, it is unlikely that they will ever entirely replace inhalation anæsthetics, in which the control of respiration is easier and attention does not have to be divided between two different parts of the body—the head and the arm.

Cyclopropane.

Among the gases which have been tried out as anæsthetics in the laboratory and afterwards used successfully on the human subject, cyclopropane has come into striking prominence since it was first used by Waters[8] in 1934. This gas is an isomer of propylene and is represented by a close-ring formula, in virtue of which it is reputed to cause no interference with metabolism. Cyclopropane has the advantage that in concentrations of ten to twenty per cent. with oxygen it will produce surgical anæsthesia with good muscular relaxation. This secures quiet respiration with ample oxygenation. Cyclopropane does not cause irritation of the respiratory tract, or damage to liver or kidneys. It is expensive, and on this account administration is only practicable in a closed apparatus using the carbon-dioxide absorption technique. This, coupled with the fact that cyclopropane is not a respiratory stimulant, necessitates a close watch for respiratory depression. As with other new agents which have proved successful experimentally, there was at first a tendency to over-estimate the value of cyclopropane. In practice, for instance, it is found that although recovery is rapid following a short administration, it is retarded after a major operation of some duration, and is accompanied by nausea in almost the same percentage of instances as in the case of ether. Further, in deep cyclopropane anæsthesia cardiac irregularities of obscure origin and significance are liable to occur. These irregularities disappear when the concentration is diluted by adding more oxygen.

The most practical method of making use of the advantages of cyclopropane is to use the gas as an adjuvant to N_2O and O in place of ether. With such a combination, adequate oxygenation is provided for. The percentage of cyclopropane in the mixture is never sufficiently high as to depress respiration unduly or to cause the cardiac irregularities referred to. Cyclopropane has now established itself as a most useful adjunct to our anæsthetic resources, especially in "bad risk" cases. In the hands of experts it gives us, when used as an adjuvant to nitrous oxide, about the most innocuous general anæsthetic prescription at the present time. A warning is, however, necessary. As it does not act as a respiratory stimulant, an overdose can easily be administered—even when the patient is a good colour. Thus it is not an agent for a novice to use. The gas is explosive (so also is ether), but the closed system helps to prevent this risk. All the same, caution is essential if diathermy is to be used at the operation. In addition, capillary oozing has been reported in some cases, though it is probably of little significance.

Local and Regional Anæsthesia.

While attention in England and America has been centred chiefly upon general anæsthesia, the trend on the Continent has been towards the development of local and regional analgesia. Finsterer's published reports[9] on regional anæsthesia in abdominal surgery show results superior to those obtained by any other method. More recently in London, Ogilvie[10] indicates equally good results in a paper personally communicated and shortly to be published. His cases are mostly gastric resections. Summing up the advantages of the method, the author states that local anæsthesia makes the operation easier for the surgeon, leading to neater and quicker work, but that it also removes all need for hurry, should extra time be wanted for some refinement. Relaxation is perfect; respiratory movements are slow and shallow; the blood-pressure is not raised nor are the capillaries dilated, while the viscera preserve their tone and movement and do not prolapse from the wound. Local anæsthesia abolishes many of the risks of the post-operative period. The patient is conscious and rational; unlike the subject of spinal anæsthesia, he can sit up; he can breathe, he can move, and he can drink, so that the likelihood of respiratory, vascular, and embolic complications is greatly diminished. Further, he has inhaled no foreign vapour or gas, so that he will not secrete respiratory mucus in excess. These advantages, Ogilvie states, continue over the later stages of recovery.

Another significant fact supporting the value of regional anæsthesia is that at the Brompton Hospital it is tending to replace general anæsthesia in the operation of thoracoplasty. Clearly, when the patient is of suitable temperament, local or regional methods obviate many of the risks associated with inhalation. The chief disadvantage of regional anæsthesia is the time-factor, and the technique must, of course, be carried out with meticulous care if it is to be successful.

Spinal Anæsthesia.

The popularity of spinal anæsthesia has waxed and waned for the last thirty years with the discovery of some new drug or some new theory as to the behaviour

of solutions injected into the subarachnoid space. Without going into details of all the methods, the mention of a few techniques may be of some practical interest.

Spinal anæsthesia has this advantage over regional anæsthesia—that one injection alone is necessary and can be made without any loss of time. There are two definite fields of applications, low (sub-umbilical), and high-reaching as far as the fourth dorsal nerve and therefore giving anæsthesia of the greater part of the wall of the thorax if necessary.

Sub-umbilical spinal anæsthesia is indicated in certain extensive pelvic operations such as excision of the rectum, operations on the bladder, and, in certain cases, hysterectomy. There is no doubt as to its value in such conditions. High spinal anæsthesia, on the other hand, produces such a fall in blood-pressure that there is no excuse for its employment when regional anæsthesia will, as Ogilvie[11] points out, produce equally good operative facilities without the accompanying fall of blood-pressure.

Of the drugs which are available for spinal anæsthesia, percaine is as good as any. The 1 : 200 solution (heavy) is preferable for low blocks in doses of from 1 to 1.3 c.c. The injection should be made in the sitting position if possible, and two or three minutes allowed for the solution to become fixed. After that the patient can be safely placed in the recumbent or "head down" position.

The 1 :1500 solution is preferable for high blocks; in virtue of its low specific gravity in comparison with the cerebro-spinal fluid, considerable controllability is afforded. The Howard Jones technique depended upon volumetric displacement using doses up to 20 c.c. gauged in accordance with the length of the patient's spine. When the patient is able to sit up for one and a half minutes, however, with the head well flexed, doses of from 5 to 10 c.c. will give anæsthesia high enough for surgery in the upper abdomen and lower part of the thorax. The advantage of the sitting position is, that in using a light solution such as 1 :1500 percaine, adequate height of anæsthesia can be obtained with a small dose. If for any reason the patient cannot sit up, Lake's method[12] of making the injection with the patient lying on the face in the reverse Trendelenberg position commends itself.

Unilateral block[13] is in theory an excellent procedure, and an attempt should always be made to obtain it in one-sided operations. In my own experience, notwithstanding every care, anæsthesia has been found to extend to the opposite side more often than not.

I have employed spinal anæsthesia for many pneumonectomies and lobectomies, but I am convinced that the resultant fall in blood-pressure and embarrassment of respiration, coupled with the lack of protection which can be afforded to the opposite lung when endotracheal anæsthesia is used, makes the practice inadvisable for these operations. High spinal anæsthesia should never be used for patients who are too ill to stand a general anæsthetic. Its main indication is the extremely robust person who is likely to prove difficult under a "general"; but here again regional anæsthesia will give all the advantages without the fall in blood-pressure if ample time is available to make the injections.

Local, regional, or spinal anæsthesia with basal narcotics is a tempting proposi-

tion. If, however, it is decided in a given case that the patient is too ill to have a general anæsthetic, it is highly improbable that he is also too ill to sustain the depression of complete basal narcosis. A sedative such as omnopon is allowable, but obviously the patient will not stand avertin except in very special cases. In any event, the effect of the basal narcotic may wear off during the course of the operation, leaving the surgeon with an uncontrollable patient.

Conclusion.

Before passing to a conclusion, I should like to deal with a few oddments which in any review of anæsthetics are difficult to fit in their proper place. These will not, however, include an account of those post-operative effects for which anæsthetics have been given wholesale blame in the past, i.e., vomiting, pulmonary complications, abdominal distension, and retention of urine.

The limitations of machinery have already been referred to, and it has been explained that the possession of an anæsthetic apparatus is no panacea for poor anæsthesia. The chief value of the apparatus is that it secures regular dosage : but the anæsthetist must familiarise himself with the controls of whatever machine he uses, in the same manner as he is expected to do with the controls of a motor-car. To continue the simile, he will be careful to note the difference between the accelerator and the brake. He must keep his eyes on the road and his hands on the wheel. Failing these precautions, he is liable to drive badly and possibly have an accident, even with a Rolls Royce. Success in the use of anæsthetic apparatus can only be attained by a close watch on the needs of the patient—and these needs, like road conditions, are liable to change at any moment.

If an apparatus is used, it should be equipped with a sight-feed of some kind to ensure regular delivery of gases and oxygen in accurately gauged proportions and quantities. Dry-flow meters serve this purpose best. The principle involving carbon dioxide absorption in a closed circuit bids fair to displace other inhalational methods, on account of economy and portability, apart from the physiological advantages already referred to.

Two important points concerning the relation of surgeon to anæsthetist are hæmorrhage and muscular rigidity. If a patient is still able to bleed normally during operation, this should surely be a matter for congratulation to the anæsthetist rather than blame—some of us may remember the days when only praise was heard if a patient, on being incised, revealed tissue as avascular as a slice of bacon.

It is possible to produce general anæsthesia, safe for the patient, by a combination of various agents in harmless, or as we might term it, atraumatic doses. Associated with this anæthesia is immobility, but not necessarily muscular relaxation, which depends on the abolition of intrinsic elasticity and all those complicated factors which maintain muscular tone. If we are prepared to submit our patient to all the risks of ether saturation, immediate and remote, absolute flaccidity can be obtained. Although I sympathise freely with the surgeon who calls for such relaxation in abdominal cases—precisely these cases in which after-effects such as vomiting and bronchitis are most disturbing—I hold strongly that the end does not justify the

means, and would put forward a plea for compromise and collaboration. It must be realised that the muscles are not merely draped upon the skeleton. They have both origins and insertions, and between these points there exists in healthy muscle some intrinsic tone. If the stretch upon a muscle is increased, as it can be by abnormal posture, difficulty of access is often increased.

The closure of the acute abdomen with distended intestine is a common problem which anæsthetists are expected to solve (sometimes unreasonably). In such cases the distended gut in the abdomen resembles the inner tube of a tyre which has burst through its cover. We would not expect to replace the protruding inner tube without preliminary deflation. It is the same with the distended gut. The contents can be let out with the aid of a trocar and canula, and the intestine can not only be replaced easily, but will recover its normal tone more quickly. The extra time and trouble involved in employing local anæsthesia of the abdominal wall will repay the surgeon well both by increasing the comfort in which he will carry out his manipulations and by the improved post-operative condition of his patient.

It is clear, I think, that the attainment of the common ideal of both surgeons and anæsthetists—namely, improvement in operative results—entails some departure from the haphazard routine of the mask and drop-bottle, efficient though the latter may be on some patients who are good risks. But it is too much to expect a newly qualified doctor, equipped with a certificate to say that he has given a dozen anæsthetics, to employ all the refinements which make the difference between good and bad anæsthesia in the hands of an expert. No house surgeon is expected to perform major surgery, except in emergency, although he may be already a good surgical technician. (After all, surgery can be practised in the dissecting-room.) He is expected, however, to give major anæsthetics. Anæsthetists must therefore be trained. However much the general practitioner may regret incursion on yet another of his preserves, it is apparent that anæsthesia, if it is to be efficient, must be a speciality. In this respect the institution of the Diploma in Anæsthetics has already done much to improve the position. In the future it will not be enough for a doctor to say "I am an anæsthetist." He will have to produce the credentials which prove that he has given some attention to the study of the subject, just as the possession of the Fellowship does for the surgeon.

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